



Composite Propane Cylinders Current and Future

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Exemption Process

- Composite propane cylinders are currently not an explicitly-permitted type in 49 CFR
- Therefore, for use in the US, manufacturers submit an exemption request to the US DOT
- Exemption requests contain:
 - Manufacturing materials and methods
 - Performance testing
 - Inspections
 - Quality assurance procedures

Exemption Process (cont'd)

- And the negotiations begin.....
 - DOT reviews request and proposes changes, mfg'r accepts some and proposes other changes,
 - Until agreement is reached
- Because this product type had no precedent (low pressure, non-metallic – non-load-bearing or no liner), the first exemptions were somewhat delayed
- Final exemptions have been granted to two mfg'rs
 - Lite Cylinder (TLCCI), Franklin, TN, DOT-E 13105
 - Pressure shell is currently mfg'd by Composite Scandinavia, Sweden
 - Lite Cylinder US manufacturing facility expected to be on-line late 2005/early 2006
 - Ragasco, Raufoss, Norway, DOT-E 12706

Exemption Process (cont'd)

- Final exemptions for both cylinders include testing, inspection, and quality assurance procedures that were extracted from
 - EN 12245 (Transportable gas cylinders → fully wrapped composite cylinders)
 - ISO 11119-3 (Gas cylinders of composite construction → specification and test methods → fully wrapped fiber reinforced composite gas cylinders with non-load-sharing metallic or non-metallic liners)
 - US DOT FRP-1 (Basic requirements for fiber reinforced plastic (FRP) Type 3FC composite cylinders)

Exemption Process (cont'd)

- Exemptions call for

- Inspections and Verifications by Independent Inspection Agency
- Pressure Relief devices in accordance with §173.301(f)
- 15 year service life
- Filling requirements per DOT 4BA
- 5 year requalification: visual and proof pressure
- Vacuum (Ragasco only)
- High Temperature Creep
- Permeability
- Flawed cylinder test
- Drop Test
- Torque test on neck boss
- Water boil test (13105 only)

From EN 12245 and ISO 11119-3

Exemption Process (cont'd)

- International manufactures also apply for and are granted “DOT approval” of their manufacturing facilities and methods
- Both Composite Scandinavia and Ragasco have been granted approvals – therefore:
 - Composite Scandinavia and Ragasco make “exempted” cylinders in “approved” facilities

Power of US DOT Exemption

- Same as the CFR that is for which the exemption is granted
- Exemptions are published in the Federal Register as law
- DOT exemptions have the statements:

“The safety analyses performed in development of this exemption only considered the hazards and risks associated with transportation in commerce.

The safety analyses did not consider the hazards and risks associated with consumer use, use as a component of a transport vehicle or other device, or other uses not associated with transportation in commerce.”

- This is NOT a limitation of the exemption – it is a limitation of 49CFR
 - Therefore → Lite Cylinder and Ragasco cylinders do not have DOT approval for consumer use → nor do any Worthington Cylinder or Manchester Tank cylinder

Composite Cylinders – What are they?



Lite Cylinder/Composite Scandinavia

- Two piece
- Linerless
- ABS jacket
- Currently on the market



Ragasco

- One piece
- Blow molded PET liner
- HDPE jacket
- US entry late 2005, early 2006

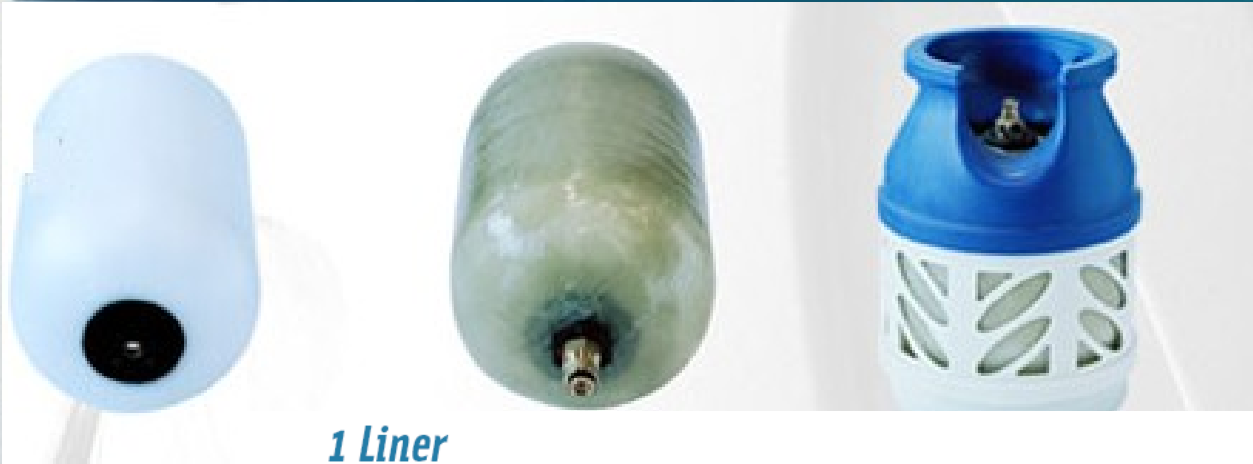
Composite Cylinders – What are they?



Kompozit-Praha (Prague, Czech Republic)

- One piece
- Blow molded PET liner
- HDPE jacket
- Early in the exemption process, US entry likely late 2006, early 2007

Composite Cylinders Construction One Piece



1 Liner

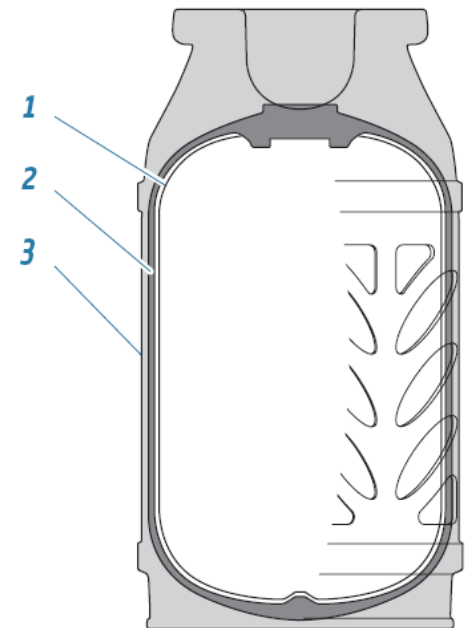
The seamless blow-moulded liner provides the inner gas barrier. It is made of a tough polymeric material and is chemical resistant. The boss is integrated into the liner.

2 Composite layer

This load-carrying layer consists of a mix of fibre-glass and resin. This composite material is applied in a filament winding process and has a great capacity to withstand pressure. An advanced curing process ensures the see-through feature.

3 Outer casing

The injection-moulded outer casing provides protection for the pressure vessel as well as for the valve. It has ergonomic handles for easy lifting and stacking function is incorporated. The casing also creates the distinct design of the cylinder.



Composite Cylinders Construction

Two Piece



- Formed by wrapping fiberglass fibers around a mandrel in multiple directions, saturating the fibers with resin to create each half of the cylinder
- Appropriate holes are drilled in each half and the two halves are bonded together to create the cylinder



Composite Cylinders – Benefits

- Translucent to view remaining fuel level
- Light weight (tare wt 12 lbs, vs steel's 19 lbs)
- Easily customized
- Corrosion and impact resistant
- Excellent fire performance characteristics



Composite tanks will cost more than steel and, at least initially, are likely to be in niche markets and specialty applications

Composite Cylinders – Significance to the Propane Industry

- Propane industry, through PERC, funded a program to develop a template for the exemption process
 - Template was developed through a industry-wide working group of over 40 members
 - Intent was to establish a guide for assisting a cylinder manufacturer through the exemption process
- BUT → The propane industry will not likely see an increase in propane sales volumes because of outdoor use of composite propane cylinders
- Real interest is in new products (using more propane) that will use the features of composite cylinders

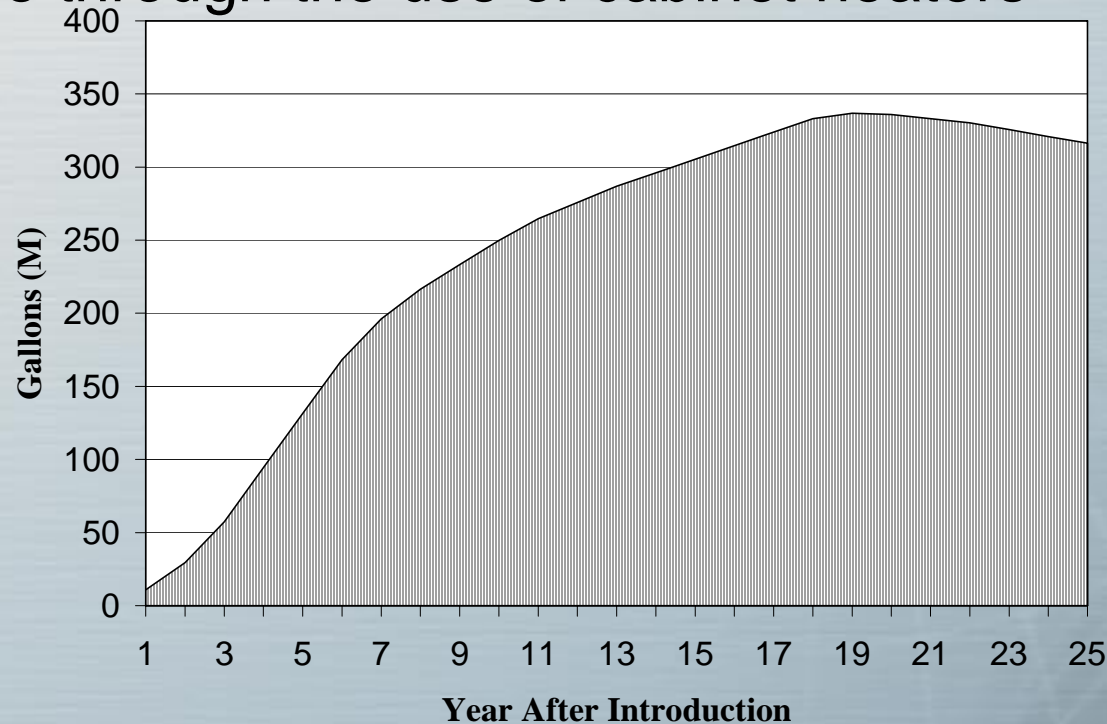
Composite Cylinders – New Appliances

- Initial products expected to be cabinet heaters, currently in use worldwide
- Later products could include portable cooking appliances



Composite Cylinders – New Appliances

- Market study shows large potential for increased propane sales volume through the use of cabinet heaters



- Problem → indoor use of cabinet heaters are prohibited by NFPA 58, the LP Gas Code

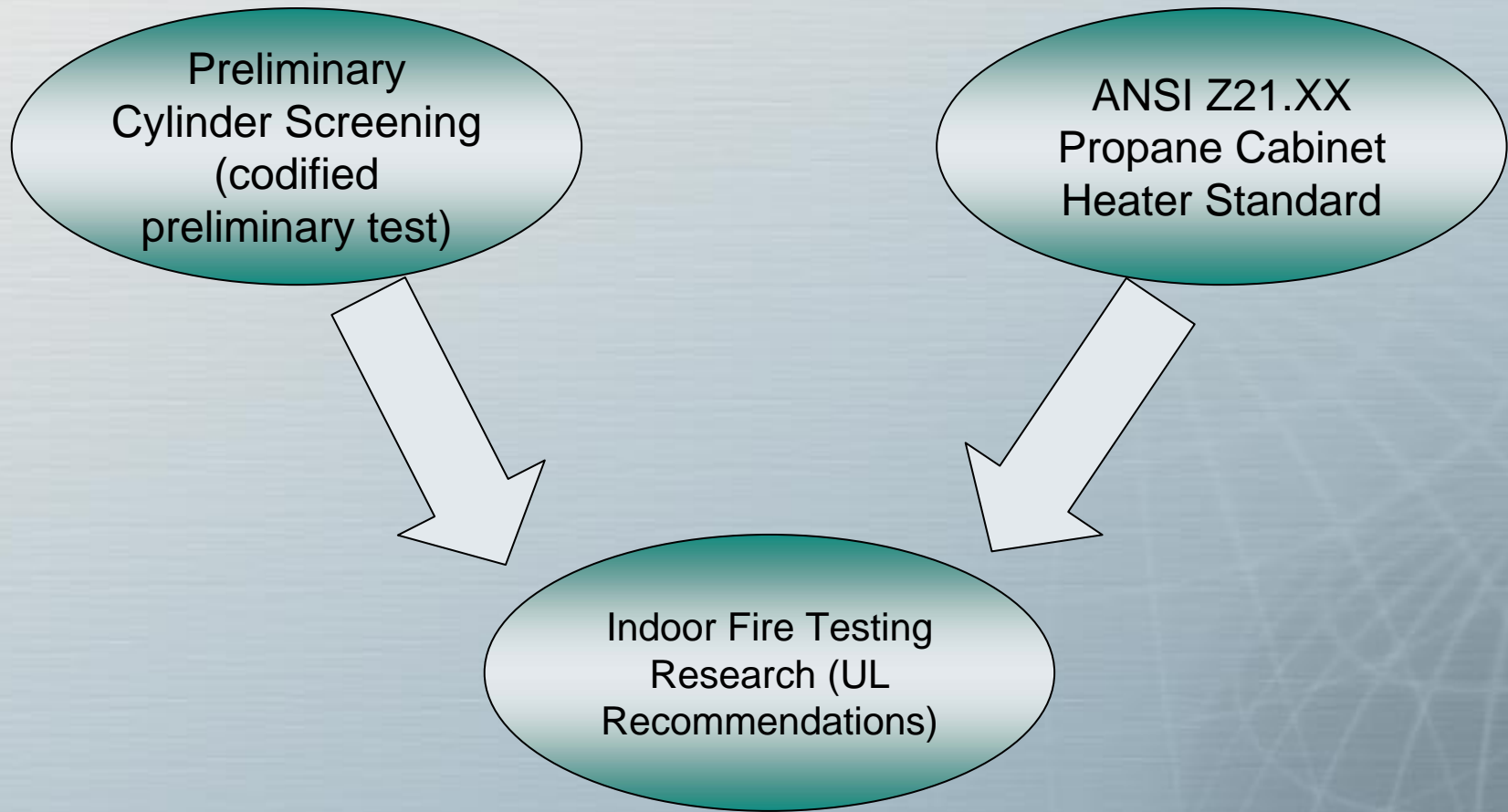
Composite Cylinders – Indoor Use

- NFPA 58 is currently being revised for release in 2007
- NPGA has made several proposals to modify NFPA 58 to allow cabinet heaters with composite cylinders
- Proposals approved for letter ballot to the 58 Technical Committee
- Many steps from now to inclusion into NFPA 58-2007
 - NFPA 58 Committee Letter Ballot (Fall 2005)
 - NFPA 58 Committee meeting on comments – Mar 2006
 - Full NFPA – 2006
 - NFPA Standards Council - 2007

Composite Cylinders – Data needed to support NPGA's proposals

- Questions about indoor use – mostly related to standards for heaters and cylinders
 - Heater standard
 - Connection and fuel line (must prevent std cylinder from being used indoors), ODS, surface temperatures, controls, labeling
→ being addressed by GAMA Cabinet Heater Task force in development of new ANSI Z21.xx standard
 - Cylinder standard – data needed to show performance in fires
- Through feedback from the fire protection community, fire testing was performed in two steps:
 - Preliminary testing – initial screening, little instrumentation
 - Detailed testing – performed in simulated room with heaters and cylinders, thoroughly instrumented

Composite Cylinder and Appliance Test Procedure – Conceptual Steps



Preliminary Testing:



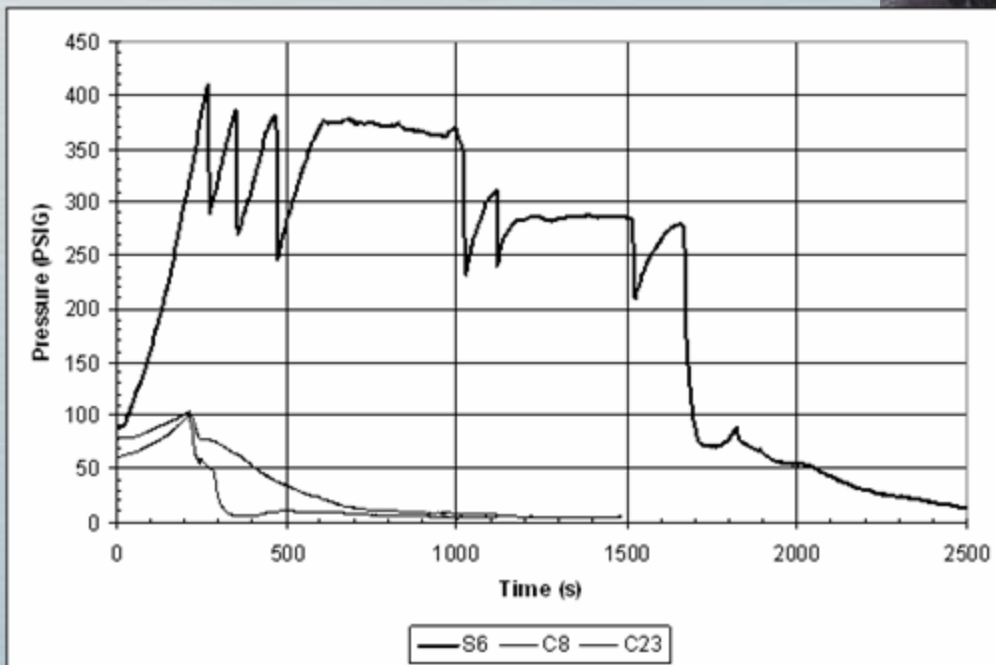
Horizontally Oriented Cylinder



Vertically Oriented Cylinder

Preliminary Testing: Composite cylinder after test; residual propane continues to burn; no rupture

S6, C8 and C23 with Med Fire; Heating Base; Horizontal Position; High Fill Level

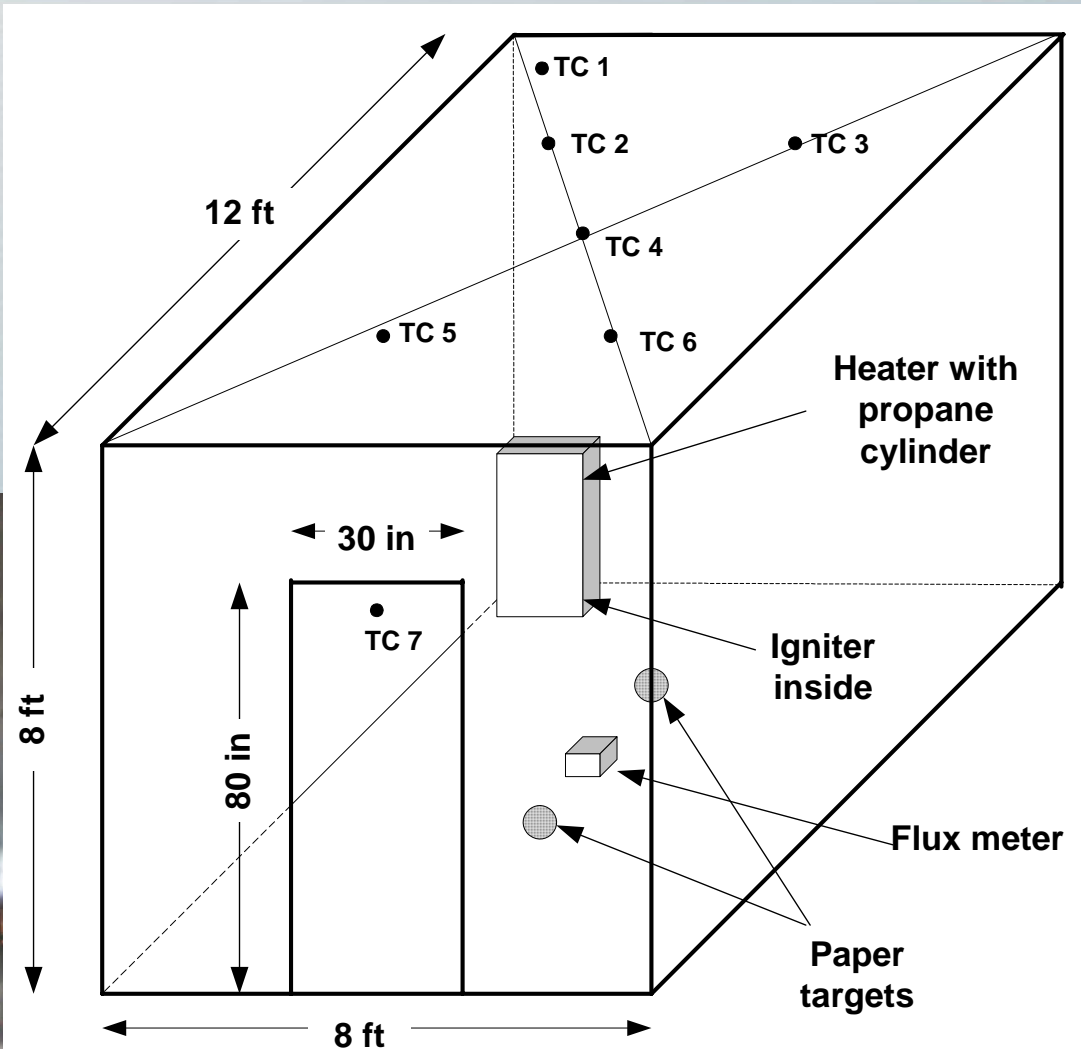


Detailed Fire Testing

- Battelle, NFPA's Fire Protection Research Foundation, and Underwriters Laboratory worked with several members of the fire protection community to develop a 3 step test program
 - Task 1 – Cylinder heat release rate (cylinder combusted empty)
 - Task 2 – What is the effect of a burning heater+cylinder on a room?
 - Task 3 – What is the effect of a burning room on the heater + cylinder

Note – FPRF and UL were contractors to Battelle and do not endorse the products discussed here

UL Test Facility – 120' x 120' x 50' burn hall – fully instrumented and video recorded



Task 2 – Heater+Cylinder Effect on Room

Before



After



Task 3 – Effect of Room on Heater+Cylinder

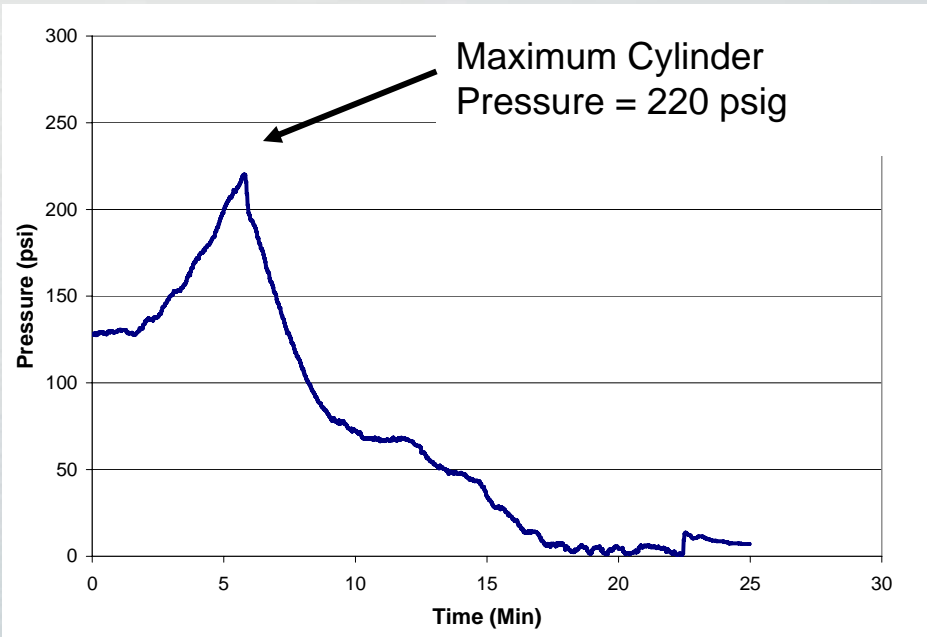
Before



After

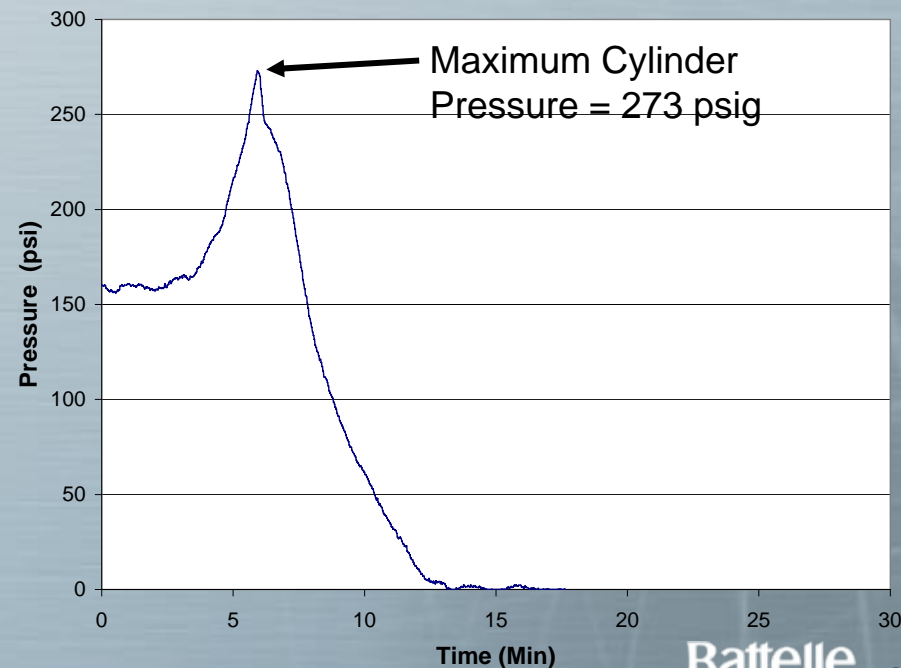


Cylinder pressures



Task 2 – Heater+Cylinder Effect on Room

Task 3 –Effect of Room on Heater+Cylinder



Composite Cylinders: Summary

- Two manufacturers have exemptions for cylinders for outdoor use (grills and other); a third has applied
- Propane industry is supportive of developing new products to take advantage of the composite cylinders' benefits, including indoor use of cylinders
- NPGA has proposed modifications to NFPA 58 to allow indoor use of cabinet heaters with composite cylinders
- Composite cylinder fire test performance to date has been encouraging – good comments from fire protection community observers
- Proposals are progressing through the NFPA revision process – final approval/rejection on 2007